Wilson Bulletin, 116(2), 2004, pp. 163–166

BEHAVIORAL INTERACTIONS BETWEEN FIRE ANTS AND VERTEBRATE NEST PREDATORS AT TWO BLACK-CAPPED VIREO NESTS

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ABSTRACT.—We report on behavioral interactions between fire ants (*Solenopsis invicta*) and vertebrate predators at two Black-capped Vireo (*Vireo atricapilla*) nests at Fort Hood, Texas. In the presence of fire ants, an eastern woodrat (*Neotoma floridana*) failed to depredate a clutch of vireo eggs at one nest, while a rat snake (*Elaphe obsoleta lindheimeri*) depredated nestlings at another nest, despite fire ants swarming the nest. Neither nest was successful. Direct and indirect effects of interactions among nest predators on avian nesting success need further assessment. *Received 21 November 2003, accepted 7 June 2004.*

The red imported fire ant (*Solenopsis invicta*) is an invasive species that occurs throughout much of the southern United States (Porter et al. 1991, Callcott and Collins 1996, O'Keefe et al. 2000), where it poses a serious threat to terrestrial communities (Wojcik et al. 2001, Holway et al. 2002). It preys upon birds (Sikes and Arnold 1986, Allen et al. 1995, Kopachena et al. 2000), small mammals (Killion et al. 1995, Ferris et al. 1998), and reptilian eggs and hatchlings (Mount et al. 1981, Buhlmann and Coffman 2001, Parris et al. 2002). Fire ants may reduce population densities of small mammals (Killion et al. 1995, Ferris et al. 1998) and cause shifts in small mammal foraging patterns (Holtcamp et al. 1997). Tuberville et al. (2000) suggest that fire ants also may influence snake populations, but there is no evidence that they depredate adult snakes. Fire ants appear to out-compete native ants and arthropods for invertebrate prey (Apperson and Powell 1984, Morrison 2002). Competition between fire ants and other predators for vertebrate prey, however, has not been documented except in the recent case where fire ants consumed shrike-cached food (Allen et al. 2001). Here, we document the behavioral interactions between fire ants and two vertebrate nest predators, an eastern woodrat (*Neotoma floridana*) and a Texas rat snake (*Elaphe obsoleta lindheimeri*), at two nests of the Black-capped Vireo (*Vireo atricapilla*).

METHODS

Predator activity was recorded as part of ongoing monitoring and management of Black-capped Vireos at Fort Hood, an 88,500-ha military installation in Bell and Coryell counties, Texas (30° 10′ N, 97° 45′ W). Twelve infrared video systems (Fuhrman Diversified, Inc., Seabrook, Texas) were deployed to monitor 142 nests for 1,589 exposure days (773 in the incubation stage and 816 in the nestling stage) from 1 April to 31 July, 1998–2001. A detailed description of the video-monitoring protocol is given in Stake and Cimprich (2003). We quantified predation events and predator interactions when fire ants were at vireo nests. Vireo behavior was categorized as aerial defense when birds were observed in the video monitor at least once within a 20-sec interval and perched on the focal nest for no longer than 2 sec. During aerial defense, vireos actively pecked at and removed fire ants swarming the nest.

Ants from vireo nests were identified in the field as fire ants (by MMS) during daily maintenance of video cameras. In a separate study, SJT (unpubl. data) collected ant samples

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across Fort Hood at 135 points on a 2,000-m grid, and also conducted bi-monthly ant sampling for one year at 150 bait trap stations in vireo nesting habitat. This vouchered material was identified in the laboratory, and the only *Solenopsis* species in these samples was *S. invicta*. On rare occasions the native fire ant, *S. geminata*, has been collected at bait stations in other studies at Fort Hood (C. E. Pekins pers. comm.), leaving open the remote possibility that the ants observed in our study could have been native fire ants.

RESULTS

Of 134 vireo nests, 48 (35.8%) failed due to direct predation, where predators removed or damaged some or all of the nest contents (Stake and Cimprich 2003). Fire ants were among these predators and they directly depredated 15 nests (31.3%). Abandonment by vireos in response to fire ants was the source of failure at six additional nests. Thus, fire ants caused failure at 21 nests (29.6%) when direct predation and abandonment were combined.

All depredated nests, except three, were attacked by a single predator. In the first nest, a Brown-headed Cowbird (*Molothrus ater*) removed one nestling, and 2 days later a snake consumed the remaining nestlings. At the second nest, an eastern woodrat failed to depredate a clutch of vireo eggs in the presence of swarming fire ants. At the third nest, a rat snake depredated vireo nestlings in the presence of fire ants. Interactions of predators at the second and third nest are discussed below. Based on careful examination of the video tapes, we estimate that hundreds of fire ants swarmed each of these nests.

On 15 June 1999, fire ants were observed in a vireo nest at 11:17:02 CST while the adult female was apparently sleeping and incubating her clutch of four eggs. The nest was 1.05 m high in a shin oak (*Quercus sinuata* var. *breviloba*). The female vireo started to peck at the ants 5.22 min after they arrived at the nest. Beginning 15.27 min after the arrival of the ants, the female perched on the rim of the nest and rapidly pecked to remove the ants. She actively removed ants for 2.05 min, after which she abandoned the nest and was not observed again.

An eastern woodrat approached and investigated the exposed clutch of eggs 0.83 min after the female abandoned the nest. While fire ants were present on the nest and eggs, the woodrat made physical contact with the eggs but did not depredate any of them. The woodrat remained at the nest for 0.37 min before leaving. Ants continued to swarm the nest both during and after the time that the woodrat was at the nest.

Shortly after sunrise (05:30:02) the next day, an adult male vireo arrived at the nest while fire ants continued to swarm the clutch. He immediately engaged in aerial defense of the nest. He continued this behavior for 24.97 min before attempting to incubate the clutch. The male switched between incubating and rapid pecking behaviors for another 24.03 min before abandoning the nest. At the time of abandonment, fire ants remained at and continued to swarm the nest. Despite the failed predation attempt by the woodrat and nest defense by the adult vireos, the ants remained at the nest for a total of 29.55 hr. The clutch failed to hatch. Careful examination of the eggs later revealed that one egg had a small hole in it. The egg was presumably nicked by the woodrat as fire ants are apparently unable to puncture intact egg shells, though they do forage on pipped or cracked eggs (Ridlehuber 1982, Buhlmann and Coffman 2001; this study).

At another vireo nest containing three, 8-day-old nestlings, an adult female vireo was last seen at 19:36:59 on 16 June 2000. This nest was located 0.74 m high in a Texas oak (*Q. buckleyii*). Fire ants swarmed the nest at 01:03:38 on 17 June, while all three nestlings were apparently sleeping and no adult birds were present. Beginning 16.70 min after the ants were first observed at the nest, the nestlings began to squirm and move frantically from side to side and continued to do so for the next 3.55 hr. At 04:48:20, a rat snake arrived at the nest, which was still swarming with ants. The snake investigated the nest for 2.65 min before striking and consuming a vireo nestling at 04:50:59. The snake proceeded to depredate the other two nestlings at 04:57:57 and 05:03:00 (9.62 min and 14.67 min after arriving at the nest). The snake did not appear to be affected by the ants. The snake left the nest at 05:15:04, with ants continuing to swarm the now empty nest.

At 05:18:05, an adult female vireo returned to the empty nest, where ants were still swarming. She engaged in aerial defense for 15.58 min until an adult male vireo arrived at 05:33:40. At this time, both adults continued to defend the nest, alternating in aerial defense of the nest. Fire ants were last observed at the nest at 07:05:31 and both adults abandoned the nest at 07:06:43.

DISCUSSION

Fire ants caused nest failure during this study by swarming vireo nests (resulting in nest abandonment) and by direct predation of nestlings. Our two observations of behavioral interactions between predators suggest that fire ants may contribute both positively and negatively to the nesting success of vireos. In two predation attempts, fire ants apparently deterred a mammalian predator, but not a snake, from depredating a vireo nest.

Because fire ants also impact other species, including those that may depredate vireo nests, there are a number of possible indirect effects of fire ants on vireos. Fire ants may indirectly reduce rodent populations through competition for common food sources (Killion et al. 1995, Ferris et al. 1998). Fire ants are known to prey upon small mammals (Killion et al. 1995, Ferris et al. 1998), and they may alter small mammal habitat use (Pedersen et al. 2003) and foraging patterns (Holtcamp et al. 1997) in ways that deter rodents from depredating vireo nests. Fire ants depredate pipped eggs and hatchlings of reptiles (Mount et al. 1981, Tuberville et al. 2000, Buhlmann and Coffman 2001, Parris et al. 2002), which could alter snake densities and, ultimately, rates of vireo predation.

Other indirect effects may result from the interaction between fire ants and vireos themselves. When fire ants swarm vireo nests, they induce alarm responses from adult and nestling vireos. Aerial defense by adults, and panic response by nestlings, may attract other predators, including snakes, to the nest. Although fire ants apparently are unable to breech intact eggs (Ridlehuber 1982, Buhlmann and Coffman 2001, Stake and Cimprich 2003), they are able to depredate young vireo nestlings (Stake and Cimprich 2003).

Fire ants negatively affect nest success directly via depredation and abandonment; both positive and negative indirect effects are also likely. Study of the potential indirect effects of fire ant depredation of vireos and co-occurring bird species should be a component of future studies of bird/fire ant interactions.

ACKNOWLEDGMENTS

We are grateful to the Texas Nature Conservancy and Natural Resources Branch of Fort Hood for cooperation and assistance, especially from J. D. Cornelius, C. E. Pekins, P. M. Cavanagh, and S. Jester. Useful insights were provided by S. K. Robinson. D. O. Ribble and E. J. Heske identified the woodrat. E. L. Moser and M. J. Meyer contributed to laboratory work. Research was funded through cooperative agreement DPW-ENV 97-A-001 between the Department of the Army and The Nature Conservancy; additional funds were provided through Engineer Research and Development Center and the Department of the Army under DACA88-99-D-0002-14. Information contained in this paper does not necessarily reflect the position or policy of The Nature Conservancy or the federal government, and no official endorsement should be inferred.

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